



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.10.2005 Bulletin 2005/42

(51) Int Cl.7: **F16J 15/00, B63H 23/32**

(21) Application number: **05075888.7**

(22) Date of filing: **15.04.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR
 Designated Extension States:
AL BA HR LV MK YU

(72) Inventor: **Visser, Teunis**
3361 GB Sliedrecht (NL)

(74) Representative: **van Westenbrugge, Andries et al**
Nederlandsch Octrooibureau,
J.W. Frisolaan 13,
P.O. Box 29720
2502 LS Den Haag (NL)

(30) Priority: **15.04.2004 NL 1025959**

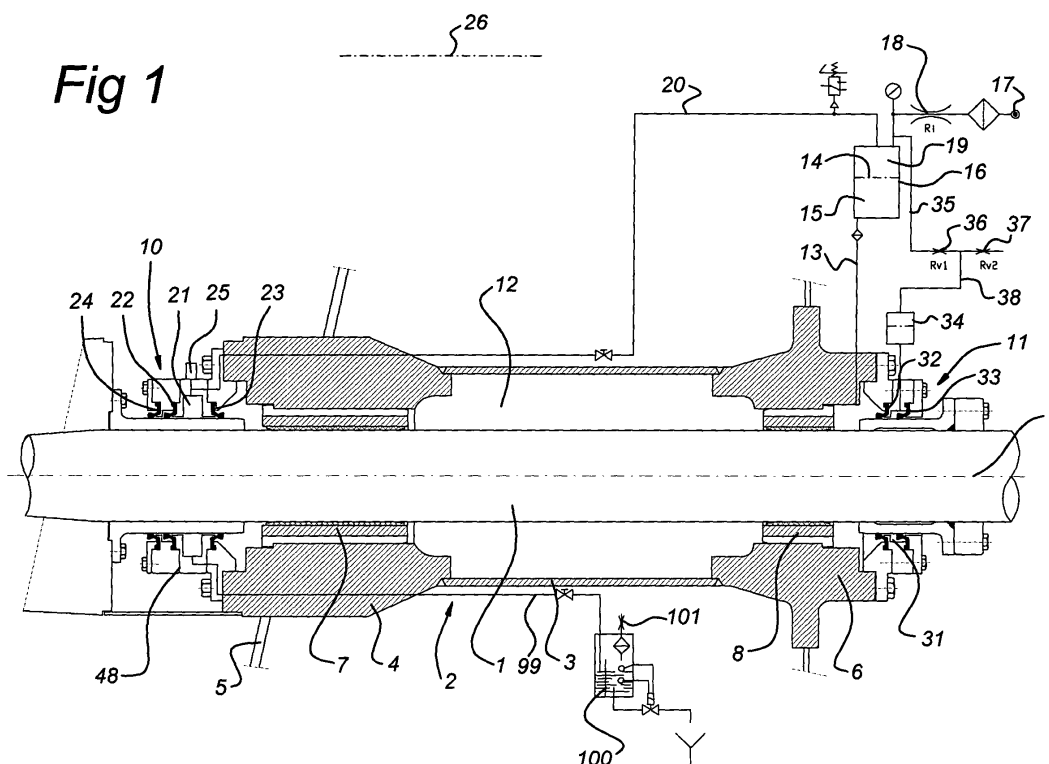
(71) Applicant: **IHC Holland NV**
2961 AW Kinderdijk (NL)

(54) **Seal construction**

(57) A seal construction comprises a shaft (1) that can rotate about its longitudinal axis, a structural part (4,5) that is oriented transversely to the shaft (1) and through which the shaft (1) is run, at least two coaxial ring seals (22,23) enclosing a pressure chamber (21) between them for sealing the shaft (1) and the structural part (4,5) with respect to one another, as well as pres-

surising means (17-20) for feeding a fluid into the pressure chamber (21) under excess pressure, which pressurising means (17-20) comprise a source (17) with a fluid under excess pressure, a throttle device (18) between the source and the pressure chamber (21) as well as a discharge (94) for discharging the fluid into the surroundings. The throttle device (18) has at least a single fixed size for the passage for the fluid.

Fig 1



Description

[0001] The invention relates to a seal construction comprising a shaft that can rotate about its longitudinal axis, a structural part that is oriented transversely to the shaft and through which the shaft is run, at least two coaxial ring seals enclosing a pressure chamber between them for sealing the shaft and the structural part with respect to one another, as well as pressurising means for feeding a fluid into the pressure chamber under excess pressure, which pressurising means comprise a source with a fluid under excess pressure, a throttle device between the source and the pressure chamber as well as a discharge for discharging the fluid from the pressure chamber.

[0002] A seal construction of this type is disclosed in JP-A 11304005. This known seal construction forms part of the rear seal of a stem tube with a propeller shaft accommodated therein. A continuous flow of the fluid from the source must be generated in the seal construction. The excess fluid escapes underneath outer ring seal(s). Feeding of a fluid to the pressure chamber creates various advantages that are associated with an improved separation between the water outside the seal construction and the space inside it, in particular the space between the propeller shaft and the stem tube that is filled with lubricant. As a consequence of the opposing pressure generated by the fluid in the pressure chamber, first of all the load on the ring seals is appreciably reduced, as a result of which the wear thereof decreases and the life is extended. By this means it is also possible to prevent lubricant leaking from the said space to the outside and thus leading to environmental pollution.

[0003] Nevertheless the known seal construction also has disadvantages. These are associated with the fact that the throttle device used in this construction enables variable adjustment. As a consequence of this it is not guaranteed that there is always such a high excess pressure of fluid that some fluid is always able to escape at the location of the seal construction (bubbling). The consequence can then be that the fluid flow ceases for a prolonged period, as a result of which fluid and/or lubricant is still able to collect in the pressure chamber to an increasing extent. Lubricant can then still escape into the surroundings.

[0004] The aim of the invention is, therefore, to provide a seal construction that does not have these disadvantages. Said aim is achieved in that the throttle device has at least a single fixed size for the passage for the fluid. With the seal construction according to the invention the fixed passage of the throttle device is chosen such that a desired flow of the fluid can always be ensured. It is possible that under certain exceptional conditions, such as high waves, which, however, occur only briefly, the outflow ceases as a consequence of a high hydrostatic pressure of short duration. However, after such a high hydrostatic pressure has fallen away, the

outflow is restored. The throttle device can optionally have multiple fixed passages, which are connected in parallel.

[0005] The seal construction according to the invention can be used in a wide variety of fields. The application in the rear seal of a stem tube and propeller shaft that has been described above is only one of multiple possibilities, as will be explained below. In such an application the structural part is accommodated in a passage for the propeller shaft in the ship's hull which has a wetted surface that is defined under a nominal liquid level. With this arrangement pressure setting means are provided that comprise a discharge valve for discharging the fluid from the source at a level below the liquid surface for setting a pressure in the pressurising means that is associated with the hydrostatic pressure of the liquid. The advantage of such pressure setting means is that pressure in the fluid can fluctuate in concert with fluctuations in the hydrostatic pressure in the liquid.

[0006] Preferably, the rear seal between the propeller shaft and the stem tube has at least one outer lip seal with a lip that is oriented backwards, as well as at least one inner lip seal with a lip that is oriented forwards, between which lip seals the pressure chamber is located. The space between the stem tube, the propeller shaft and the inner lip seal is filled with a liquid lubricant, in which lubricant a hydrostatic pressure prevails that is higher than the hydrostatic pressure of the water at the outer lip seal. In this context the space in which the lubricant is present is in communication with a closed lubricant reservoir that is at a higher level than the nominal liquid level, which lubricant reservoir has a fluid space that is in communication with the pressure setting means. In this case the pressure in the lubricant is also able to fluctuate. As a result the pressure drop over the ring seals can be kept within acceptable limits.

[0007] Furthermore, the discharge from the pressure chamber can open into a collection reservoir for collecting liquid and/or lubricant driven out of the pressure chamber. The collection reservoir is connected to the surrounding atmosphere by means of a throttle device with a passage with a single fixed size.

[0008] According to an important variant of the invention, the discharge valve is in communication with the pressure chamber. The advantage of this embodiment is that only a single line has to be used from the source to the pressure chamber. This single line makes it possible both to feed fluid to the pressure chamber and to measure the pressure in that chamber. After all, the discharge valve opens at a certain nominal pressure in the fluid, which pressure associated with opening of the valve can be measured. In addition to this discharge valve for discharging fluid into the liquid (bubbling) and thus measuring the pressure, the pressure chamber has, as already mentioned, a discharge for discharging any fluid and/or lubricant that has leaked into the pressure chamber with another portion of the fluid flow to a collection reservoir. This discharge is preferably at a low

level in the pressure chamber.

[0009] Incidentally, a separate valve for discharging fluid into the liquid (bubbling) is known per se from JP-A 7310829. However, this discharge valve is in communication with a separate line that is connected to the source and not to the pressure chamber. The disadvantage of this is that two lines are needed instead of a single line as according to the invention.

[0010] As already discussed above, the seal construction according to the invention can also be employed in fields other than the rear seal. The front seal of a propeller shaft and a stem tube surrounding the propeller shaft constitutes a further example. According to a first possibility, with this arrangement at least two successive coaxial ring seals are provided, two neighbouring ring seals of which in each case delimit a pressure chamber, which pressure chamber is connected to the source via a throttle device.

[0011] According to a further possibility, at least three successive coaxial ring seals can also be provided, of which at least two neighbouring ring seals in each case delimit a pressure chamber, one of which pressure chambers is adjacent to the space between the propeller shaft and the stem tube and the other pressure chambers are at a successively increasing distance from said space, of which pressure chambers the pressure chamber that is farthest away from the space is in communication with the surrounding atmosphere and the other pressure chambers are each connected via their own throttle device to the source, which throttle devices are connected in series such that a relatively high pressure can be generated in the pressure chamber that is adjacent to said space and a stepwise lower pressure can be set in the following pressure chambers. As a supplementary feature, a further throttle device is provided that is connected in series with the other throttle devices, which further throttle device opens into the surrounding atmosphere.

[0012] By giving the throttle devices connected in series the same throttle value, the pressure is lowered stepwise in each pressure chamber in equal steps. As a result the various seals are loaded in a virtually identical manner, which appreciably prolongs the life of the front seal. Nevertheless, if desired, different throttle values can be chosen for the various throttle devices.

[0013] In a known manner the pressure chambers can each be in communication with a respective lubricant reservoir that can be at a higher level than the associated pressure chamber, which lubricant reservoirs each have a fluid space that is in communication with the source. In the pressure chambers the pressure is then increased by the hydrostatic pressure of the lubricant column.

[0014] With the seal construction according to the invention it is extremely important that the discharge valve for discharging the fluid into the liquid functions in a reliable manner and cannot be attacked by the liquid, in particular seawater. This can be achieved in that the dis-

charge valve comprises a non-return valve as well as a bell, in which bell the non-return valve is accommodated outside the region into which the liquid is able to penetrate into the bell. The bell can be connected at the bottom to a fluid chamber that extends upwards in the bell, in which fluid chamber the non-return valve is located. The bell has outflow holes for the fluid, which outflow holes also function as feed for admitting the liquid, in particular seawater, into the bell in the space thereof that is located outside the fluid chamber.

[0015] Furthermore, the non-return valve can have a valve seat oriented upwards as well as a valve body with a rubber surface facing the valve seat. With regard to applying the desired preloading to the valve, a mass can be provided that is accommodated in the fluid chamber such that it can be guided up and down, which mass rests on the valve body by means of a pivotable seating.

[0016] As already mentioned, the seal construction according to the invention can be employed with a wide variety of installations. In addition to the abovementioned examples relating to the rear seal and the front seal of a propeller shaft and stem tube, the shaft seal of oil-filled electric motors can also be mentioned. According to yet another possibility, the seal construction according to the invention can be employed with centrifugal pumps and rotary shafts of excavators, such as cutter suction dredgers and the like.

[0017] In these cases, for example, a concentric annular throttle channel is provided that at one end is in communication with the source for admitting the fluid and that has an outlet at the other end, whilst the pressure chamber has an inlet that is connected to the outlet of the throttle channel as well as an outlet for discharging the fluid.

[0018] To bridge large pressure differences at least three successive ring seals can be provided, two neighbouring ring seals of which in each case define a pressure chamber, as well as at least two annular throttle channels such that the pressure chambers and the throttle channels are connected alternately in series, and the final throttle channel in the series is provided with the discharge for the fluid. For a pressure difference of, for example, 20 bar ten annular seals can be used, such that the pressure decreases stepwise by 2 bar in each case over the ten pressure chambers defined by this means. The consequence of this is that each annular seal is only exposed to a pressure difference of 2 bar, which appreciably extends the life.

[0019] The annular seals can be lip seals, the lip of which faces the side at relatively high pressure. In addition, a wide variety of other annular seals can be used, such as slip-ring seals.

[0020] The invention will be explained in more detail below with reference to a few illustrative embodiments shown in the figures.

Figure 1 shows an axial section of a propeller shaft construction.

Figure 2 shows an example of a fixed throttle device as used in the propeller shaft construction according to Figure 1.

Figure 3 shows an alternative embodiment of the front seal of the propeller shaft construction according to Figure 1.

Figure 4 shows a discharge valve as used in the propeller shaft construction according to Figure 1.

Figure 5 shows a further embodiment in the form of a rotary shaft seal.

Figure 6 shows a section according to VI-VI in Figure 5.

Figure 7 shows a flow diagram for the embodiment in Figures 5 and 6.

Figure 8 shows a variant of the embodiment in Figures 5 and 6.

Figure 9 shows the flow diagram for Figure 8.

[0021] The propeller shaft construction shown in Figure 1 first of all comprises a propeller shaft 1 as well as a stem tube 2 indicated in its entirety by 2 and surrounding the propeller shaft 1. This stem tube 2 comprises a pipe part 3, a rear structural part 4 that is run through the ship's hull 5 to the outside and a front structural part 6. The rear structural part 4 supports the rear bearing 7 and the front structural part 6 the front bearing 8. The propeller shaft 1 is accommodated in these bearings 7, 8 such that it is able to turn about its axis 9. The bearings 7, 8 are plain bearings and in a known manner are made of white metal.

[0022] The rear seal indicated in its entirety by 10 is provided for sealing the propeller shaft 1 with respect to the rear structural part 4. The front seal indicated in its entirety by 11 is provided for the front structural part 6. In the space 12 delimited by the propeller shaft 1, the stem tube 2 and the seals 10, 11 a quantity of fluid lubricating oil is provided, the hydrostatic pressure of which is determined, inter alia, by the height of the lubricating oil column determined by the lubricating oil level 14 of the quantity of lubricating oil 15 in the lubricating oil reservoir 16, as well as the difference in height over the line 13 by means of which this lubricating oil reservoir 16 is connected to the space 12.

[0023] On board the vessel of which the propeller shaft construction forms part there is an on-board network 17 for compressed air that is at a pressure of between approximately 7.5 and 8.5 bar. This compressed air is connected to the space 19 above the lubricating oil level 14 in the lubricating oil reservoir 16 via a fixed throttle device 18 with a single, fixed passage, as will be explained later. The throttle device 18 has a passage such that an air flow of, for example, 25 standard litres per minute is delivered. A line 20 runs from the lubricating oil reservoir 16 to the rear seal 10. At that location the line 20 is connected to a pressure chamber 21 that is defined between the lip seals 22, 23. The lip of the front lip seal 23 faces forwards towards the space 12, whilst the lip of the other lip seal 22 is oriented back-

wards. The further lip seal 24 is likewise oriented backwards.

[0024] As shown in Figure 1, the line 20 is furthermore connected to the discharge valve 25. The throttle device 18 is so selected that some compressed air continuously escapes via the discharge valve 25. This means that the pressure in the pressure chamber 21 is equal to the liquid column that is located between the discharge valve 25 and the level 26 of water in which the vessel concerned is located. Because the line 20 is connected both to the pressure chamber 21 and to the discharge valve 25, it is not necessary to install a second line that runs separately to the discharge valve 25.

[0025] The fluid containing any liquid that has leaked can be discharged from the pressure chamber 21 by means of the line 99, which leads to the collection reservoir 100. This reservoir is connected to the surrounding atmosphere by means of a throttle device 101, which likewise has a passage with a single, fixed size.

[0026] The fixed throttle device 18 according to Figure 1 is shown in more detail as an example in Figure 2. According to this example, this fixed throttle device comprises a first connector 27 located upstream, a second connector 28 located downstream, which is connected to the first, as well as a hollow needle 29 that is joined via plug 30 to the connector 28 located downstream. A specific throttle effect is obtained depending on the internal diameter and the length of the hollow needle 29; as already mentioned, according to the invention this is preferably a passage such that a specific air flow is obtained with a pressure of 7.5 to 8.5 bar on the connector 27 located upstream. As an example, a standard air flow of 25 litres per minute can be obtained.

[0027] This air flow is also used to pressurise a further pressure chamber 31 that is located between the lip seals 32 and 33. These lip seals have a lip that is oriented backwards towards the space 12 in which the lubricating oil is located. A lubricating oil reservoir 34, to which a pressure can be fed via line 35 and throttle device 36, is connected to this pressure chamber 31. This pressure is associated with the pressure as set and measured by the valve 25. This means that the pressure in the pressure chamber 31 fluctuates together with the water column up to the water level 26. Therefore, should the pressure of the lubricating oil in the space 12 increase as a consequence of an increasing draught or a high wave, the pressure in the pressure chamber 31 is also increased. The lip seal 32 is therefore not subjected to additional loading in the case of increasing pressure of the lubricating oil in the space 12 since the higher lubricating oil pressure is counteracted by the pressure of the oil in the pressure chamber 31. The life of the lip seal 32 is appreciably extended as a result.

[0028] A second throttle device 37 is coupled in series with the fixed throttle device 36. This second throttle device opens into the surroundings. The branch line 38 that leads to the lubricating oil reservoir 34 is therefore loaded with a pressure that is approximately half the

pressure in the line 35 if the throttle devices 36 and 37 are identical.

[0029] The front seal is not restricted to an embodiment with a single pressure chamber 31. As shown in the variant in Figure 3, there can also be several pressure chambers, 31, 39, 40 between four lip seals 32, 33, 41 and 42. The line 35 is now connected to three throttle devices 36, 37, 43 connected in series, the last of which opens into the surrounding atmosphere. In each case it can be a section of pipe of small internal diameter that is concerned here. The lubricating oil reservoirs 34, 45 are loaded under stepwise decreasing pressures via correspondingly positioned branch lines 38, 34, such that the pressure chambers 31, 39 also have a stepwise decreasing pressure. The pressure in the front pressure chamber 40 is the lowest, since it is exposed only to the lubricating oil column of the lubricating oil in the associated lubricating oil reservoir 47, that is in communication with the atmosphere via the line 48.

[0030] The discharge valve 25 comprises the non-return valve indicated in its entirety by 50 as well as a bell 51 provided with an opening 52 via which the fluid is discharged and seawater can possibly enter (Fig. 4). The bell 51 is closed off at the bottom by means of the fluid chamber 53 in which the valve 50 is located. The valve 50 has a valve seat 54 as well as a valve body 55, on the underside of which there is a separate, soft rubber layer 56. A mass 57 rests on the valve body 55 via the pivotable seating 58. The valve 50 is therefore held in the sealing position under the influence of gravity. Since the seating 58 is positioned centrally, a uniform pressure on the valve body is obtained.

[0031] The water can collect in the bell 51 up to a certain height around the outside of the fluid chamber 53. However, as a result of the sealing action of the valve 50 the seawater cannot reach the open communication 59 between the inside and the outside of the fluid chamber 53. Consequently, it is ensured that the valve 50 is not exposed to contaminating influences, in particular of seawater.

[0032] In the embodiment in Figures 5, 6 and 7 a rotary pipe seal is provided that comprises a fixed housing 60 and a bush 61a. The housing 60 is fixed to a fixed pipe 96 and the bush 61a to a pipe 97 that is able to rotate about the axis. The lip seals 60 to 70 form part of the housing 60. Between every two of these lip seals a pressure chamber 71 to 80 is provided, as well as an annular throttle device 81 to 90. A fluid under pressure, for example at a pressure of 20 bar, is contained inside the housing 60 and the bush 61 a and the pipes 96, 97.

[0033] According to the invention a pressurised medium, for example water, is fed to the first throttle device 81 at the location of the feed 91 as shown in Figure 6. This water fed in is at a pressure that is approximately equal to the pressure of the medium in the housing 60 and the bush 61 a and that in the present example will thus be 20 bar. This water flows via the throttle device 81 anticlockwise in Figure 6 towards the discharge hole

92, which is separated from the feed hole 90 by the stoppers 93. This water, the pressure of which has in the interim fallen in the throttle device 81, reaches the first pressure chamber 71 via the discharge hole 92. The liquid is then fed from this first pressure chamber 71 to the second throttle device 82, specifically from the hole 94.

[0034] In this way the water runs from the feed at the first throttle channel 81 to the outlet 95 that is in communication with the surrounding atmosphere. As a consequence of these successive and alternating throttle devices 81-90 and pressure chambers 71-79 the pressure decreases stepwise in regular steps, as a result of which all lip seals are loaded to only a very limited extent.

[0035] The variant in Figures 8 and 9 largely corresponds to that in Figures 5 - 7. However, the feed 92' is now connected directly in series to the discharge 94' of the pressure chambers 72' et seq. This means that in the pressure chamber 72' concerned the same pressure prevails as in the pressure chamber 72 according to Figure 5. However, the fluid is now stationary in the pressure chamber 72' and does not flow through it, as is the case with pressure chamber 72 according to Figure 5.

Claims

1. Seal construction comprising a shaft (1) that can rotate about its longitudinal axis, a structural part (4, 5) that is oriented transversely to the shaft (1) and through which the shaft (1) is run, at least two coaxial ring seals (22, 23) enclosing a pressure chamber (21) between them for sealing the shaft (1) and the structural part (4, 5) with respect to one another, as well as pressurising means (17-20) for feeding a fluid into the pressure chamber (21) under excess pressure, which pressurising means (17-20) comprise a source (17) with a fluid under excess pressure, a throttle device (18) between the source (17) and the pressure chamber (21) as well as a discharge (94) for discharging the fluid into the surroundings, **characterised in that** the throttle device (18) has at least a single fixed size for the passage for the fluid.
2. Construction according to Claim 1, wherein the structural part (4, 5) is liquid-tight and has a wetted surface that is defined below a nominal liquid level (26) and wherein pressure setting means are provided which comprise a discharge valve (25) for discharging the fluid from the source (17) at a level below the liquid surface (26) for setting a pressure in the pressurising means (17-20) that is associated with the hydrostatic pressure of the liquid.
3. Construction according to Claim 2 for the rear seal (10) of a propeller shaft (1) and a stem tube (2) surrounding the propeller shaft (1), comprising at least

one outer lip seal (22, 24) with a lip that is oriented backwards, as well as at least one inner lip seal (23) with a lip that is oriented forwards, between which lip seals (22, 23) the pressure chamber (21) is located.

4. Construction according to Claim 2 or 3, wherein the space (12) between the stem tube (2), the propeller shaft (1) and the inner lip seal (23) is filled with a liquid lubricant, in which lubricant a hydrostatic pressure prevails that is higher than the hydrostatic pressure of the water at the outer lip seal (24).
5. Construction according to Claim 4, wherein the space (12) in which the lubricant is present is in communication with a closed lubricant reservoir (16) that is at a higher level than the nominal liquid level (26), which lubricant reservoir (16) has a fluid space (19) that is in communication with the pressure setting means (25).
6. Construction according to one of the preceding claims, wherein the discharge (98) opens into a collection reservoir (100) for collecting liquid and/or lubricant driven out of the pressure chamber (21).
7. Construction according to Claim 6, wherein the collection reservoir (100) is connected to the surrounding atmosphere by means of a throttle device (101) with a passage with a single fixed size.
8. Construction according to one of Claims 2 - 7, wherein the discharge valve (25) is in communication with the pressure chamber (21).
9. Construction according to one of Claims 2 - 8 for the front seal (11) of a propeller shaft (1) and a stem tube (2) surrounding the propeller shaft (1), wherein at least two successive coaxial ring seals (32, 33, 42) are provided, two neighbouring ring seals of which in each case delimit a pressure chamber (31, 40), which pressure chamber (31, 40) is connected to the source via a throttle device (36, 43).
10. Construction according to Claim 9 for the front seal (11) of a propeller shaft (1) and a stem tube (2) surrounding the propeller shaft (1), wherein at least three successive coaxial ring seals (32, 33, 42) are provided, two neighbouring ring seals of which in each case delimit a pressure chamber (31, 40), one (31) of which pressure chambers is adjacent to the space (12) between the propeller shaft (1) and the stem tube (2) and the other pressure chambers (39, 40) are at a successively increasing distance from said space (12), of which pressure chambers the pressure chamber (40) that is farthest away from the space (12) is in communication with the surrounding atmosphere and the other pressure cham-

bers (31, 40) are each connected via their own throttle device (36, 43) to the source (17), which throttle devices (36, 43) are connected in series such that a relatively high pressure can be generated in the pressure chamber (31) that is adjacent to said space (12) and a stepwise lower pressure can be set in the following pressure chambers (39, 40).

11. Construction according to Claim 10, wherein a further throttle device (37) is provided that is connected in series with the other throttle devices (36, 43), which further throttle device (37) opens into the surrounding atmosphere.
12. Construction according to Claim 9, 10 or 11, wherein the pressure chambers (31, 39, 40) are each in communication with a respective lubricant reservoir (34, 45, 47), which lubricant reservoirs (34, 45, 47) each have a fluid space that is in communication with the source (17).
13. Construction according to one of Claims 2 - 12, wherein the discharge valve (25) comprises a non-return valve (50) as well as a bell (51), in which bell (51) the non-return valve (50) is accommodated outside the region into which the liquid is able to penetrate into the bell (51).
14. Construction according to Claim 13, wherein the bell (51) is connected at the bottom to a fluid chamber (53) that extends upwards in the bell (51), in which fluid chamber (53) the non-return valve (50) is located and the bell (51) also has an outlet opening (52) for discharging the fluid from, and optionally admitting the fluid to, the bell (51) in the space thereof that is located outside the fluid chamber (53).
15. Construction according to Claim 14, wherein the non-return valve (50) has a valve seat (54) oriented upwards, a valve body (55) as well as a rubber surface (56) facing the valve seat (54).
16. Construction according to Claim 15, wherein a mass (57) is provided that is accommodated in the fluid chamber (53) such that it can be guided up and down, which mass (57) rests on the valve body (50) by means of a pivotable seating (58).
17. Construction according to Claim 1, wherein at least one throttle channel (81-90) is provided that at one end is in communication with the source (17) for admitting the fluid and that has an outlet (92) at the other end, which pressure chamber (71-79) has an inlet that is connected to the outlet (92) of the throttle channel (81-90) as well as an outlet (94) for discharging the fluid.
18. Construction according to Claim 17, wherein at

least three successive ring seals (61-70) are provided, two neighbouring ring seals of which in each case define a pressure chamber (71-80), as well as at least two annular throttle channels (81-90) such that the pressure chambers (71-80) and the throttle channels (81-90) are connected alternately in series, and the final throttle channel (90) in the series is provided with the discharge (95) for the fluid.

19. Construction according to Claim 16 or 17, wherein the annular seals (61-70) comprise lip seals, the lip of which faces the side at relatively high pressure.

15

20

25

30

35

40

45

50

55

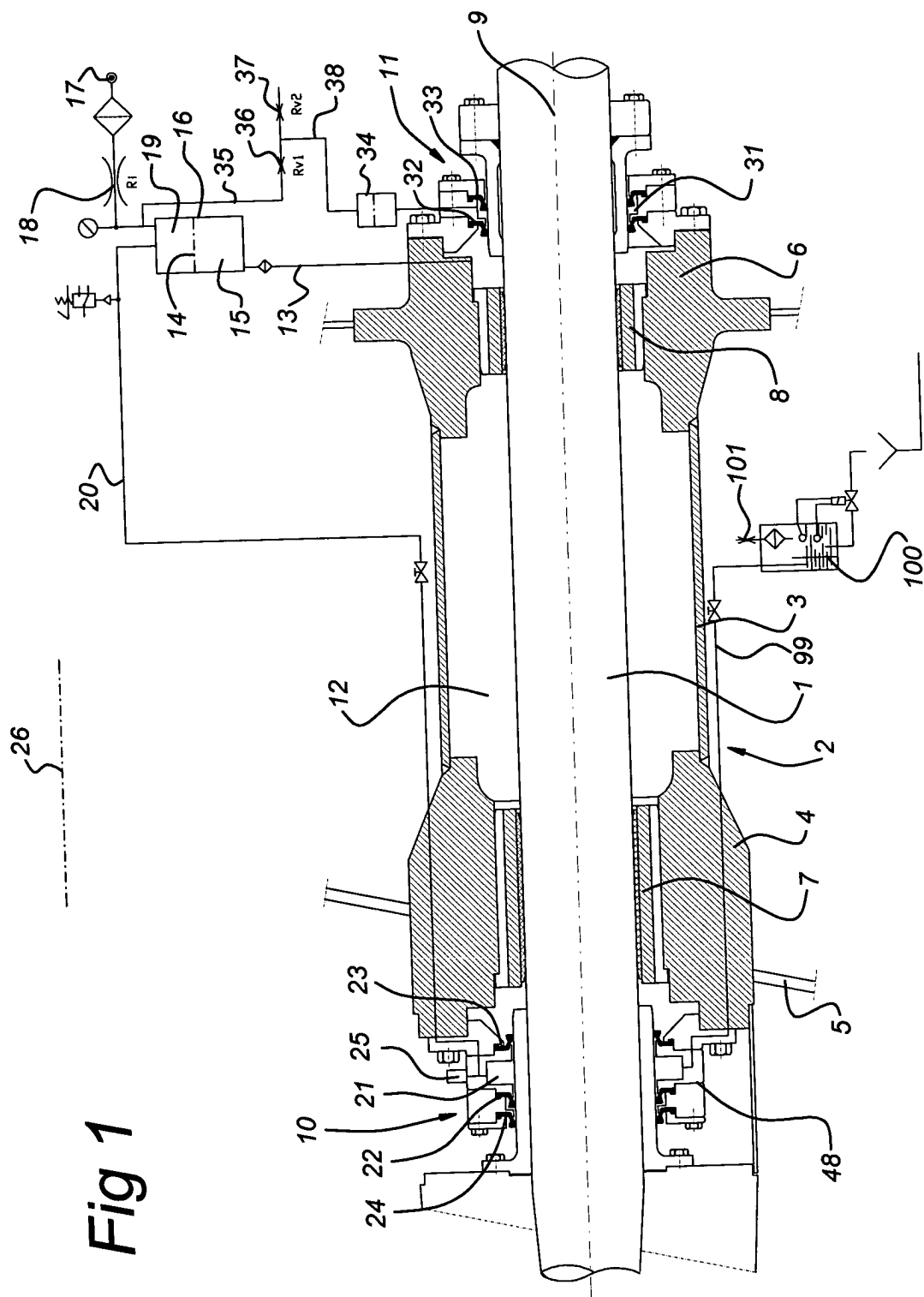


Fig 2

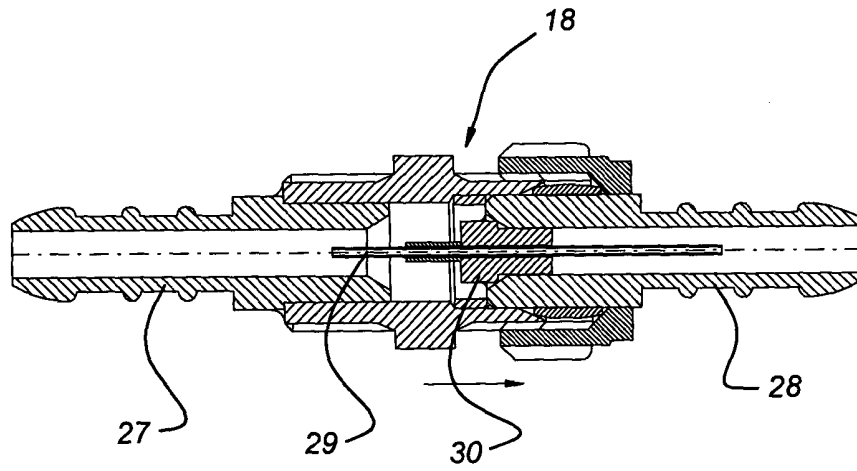


Fig 4

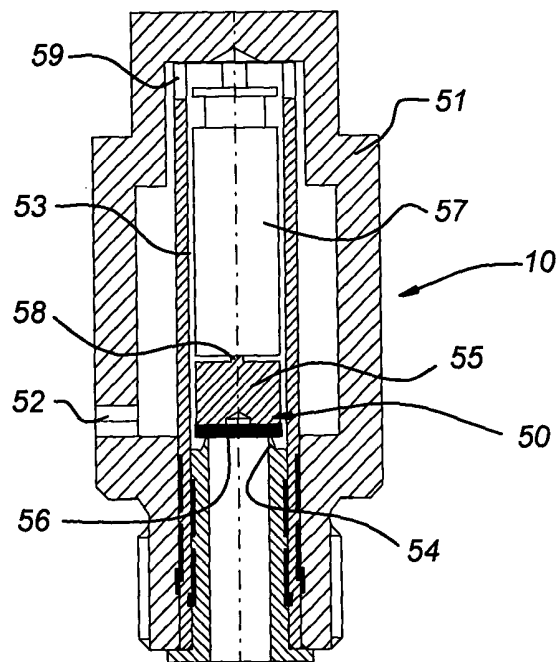


Fig 3

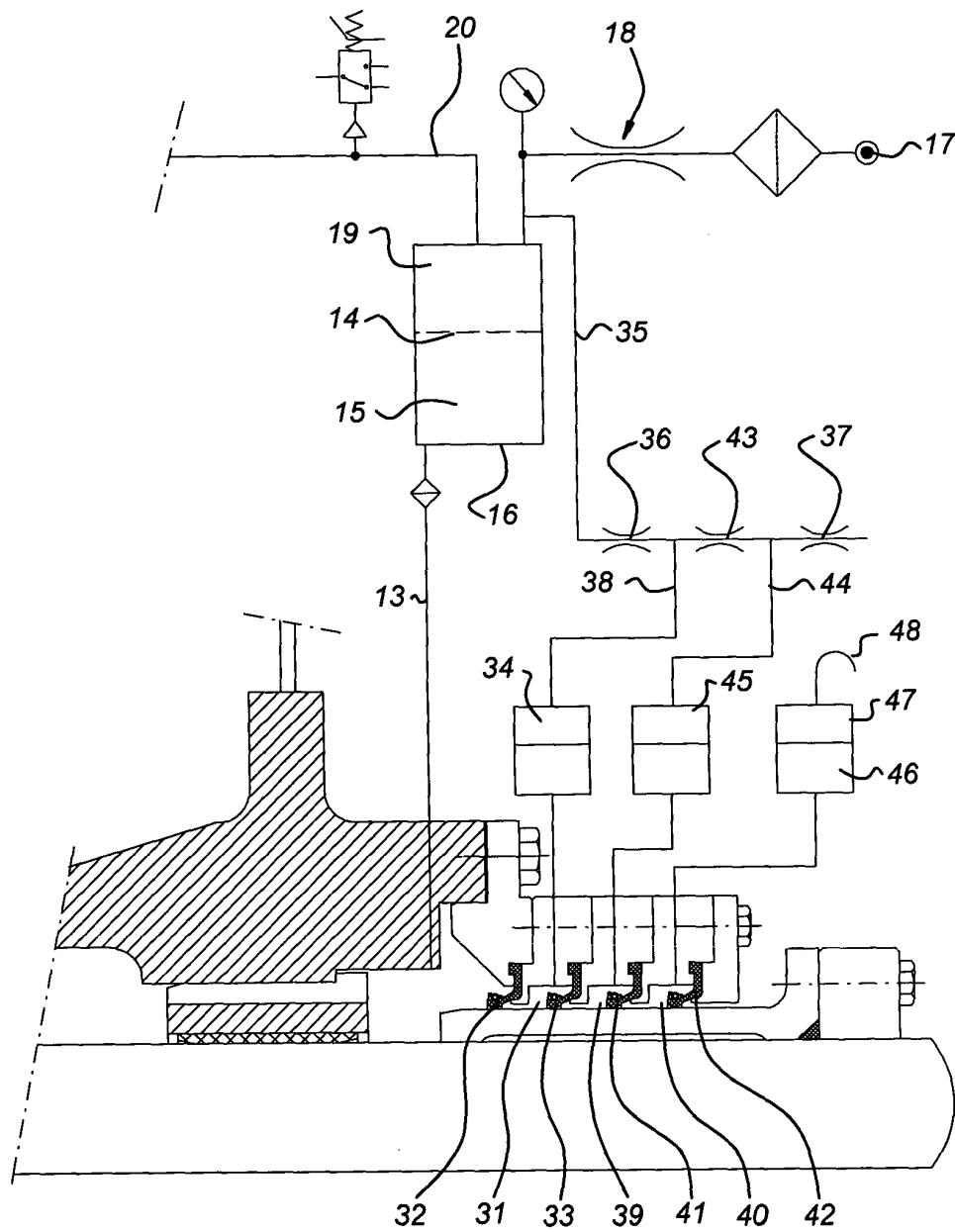


Fig 5

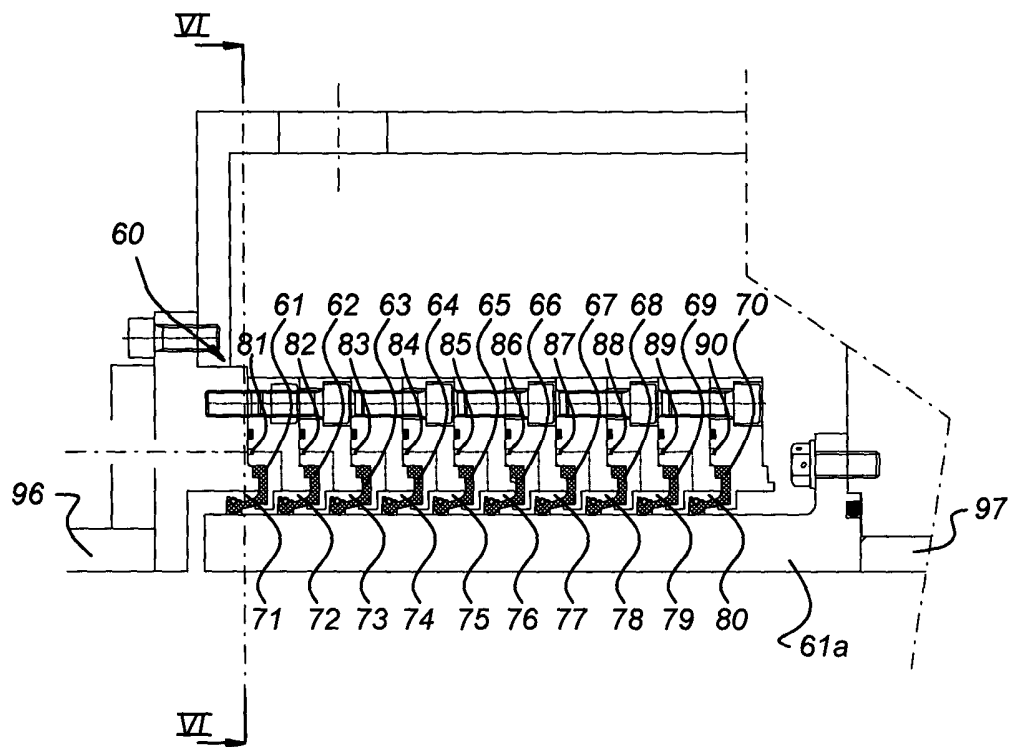


Fig 6

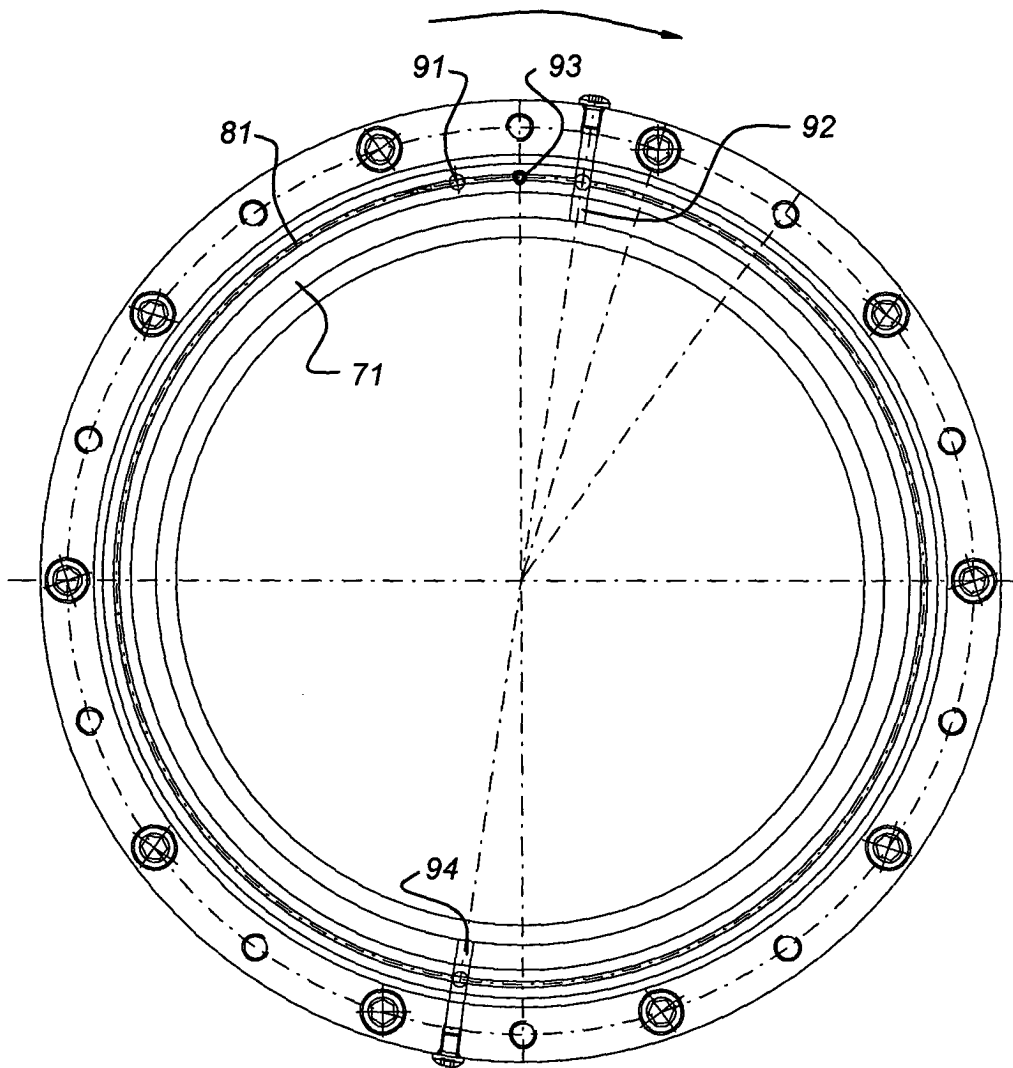


Fig 7

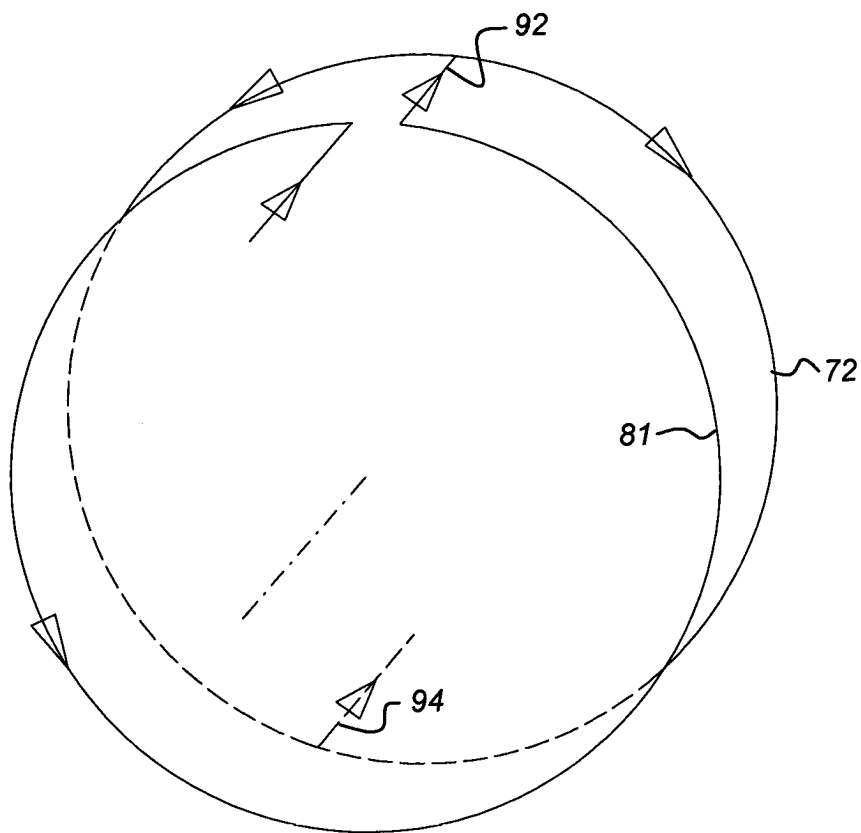


Fig 8

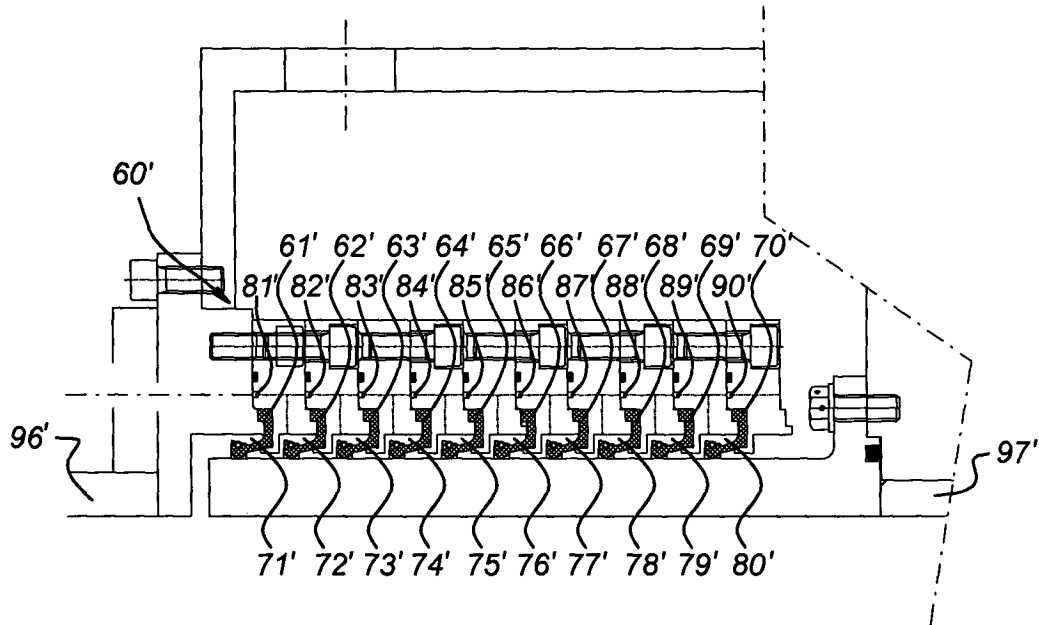
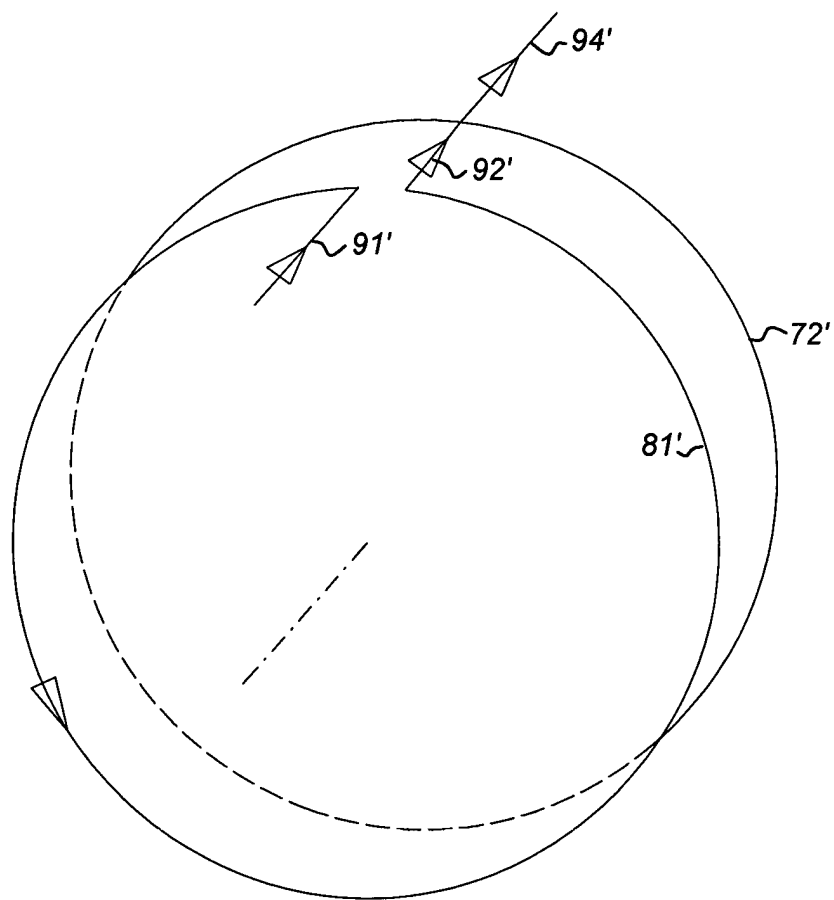


Fig 9





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5888

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 1 213 221 A (KOBELCO MARINE ENGINEERING CO) 12 June 2002 (2002-06-12) * paragraphs [0041], [0042], [0047] * * figures 1,2 *	1,6,7	F16J15/00 B63H23/32
X	US 4 085 941 A (BUNYAN THOMAS WALTER ET AL) 25 April 1978 (1978-04-25) * column 2, line 52 - column 3, line 10 * * figure *	1,6,7	
X	DE 37 18 411 A (BLOHM VOSS AG) 15 December 1988 (1988-12-15) * column 4, lines 15-32 * * figures 1,2 *	1,6,9	
X	US 5 683 278 A (HILLIG HOLGER ET AL) 4 November 1997 (1997-11-04) * column 4, lines 10-16 * * column 4, lines 26-39 * * column 6, lines 28-50 * * figures 1-4 *	1,6,9	
Y		2-4,13	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Y	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 03, 29 March 1996 (1996-03-29) & JP 07 310829 A (KOBELCO MARINE ENG:KK), 28 November 1995 (1995-11-28) * abstract * * paragraphs [0017], [0022] - [0024] * * figure 1 *	2-4,13	F16J B63H
X	US 5 795 198 A (PEDONE ANTONIO) 18 August 1998 (1998-08-18) * column 3, line 60 - column 4, line 4 * * column 6, line 35 - column 7, line 14 * * figures 1,1d,3,4,6,7 *	1,17,19	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 21 July 2005	Examiner Van Wel, O
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

2
EPO FORM 1503 03.82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5888

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 02, 29 February 2000 (2000-02-29) & JP 11 304005 A (COBELCO MARINE ENGINEERING:KK), 5 November 1999 (1999-11-05) * abstract *	1	
A	----- EP 0 335 368 A (DOVER JAPAN INC) 4 October 1989 (1989-10-04) * column 4, lines 27-53 * * figures 1,2 * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Place of search The Hague		Date of completion of the search 21 July 2005	Examiner Van Wel, O
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

2
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 07 5888

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-07-2005

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1213221	A	12-06-2002	DE 60102064 D1	25-03-2004
			DE 60102064 T2	30-12-2004
			EP 1213221 A1	12-06-2002
			JP 2002234493 A	20-08-2002

US 4085941	A	25-04-1978	NONE	

DE 3718411	A	15-12-1988	DE 3718411 A1	15-12-1988
			CN 1030127 A ,B	04-01-1989
			GB 2205365 A ,B	07-12-1988
			JP 2525225 B2	14-08-1996
			JP 64001693 A	06-01-1989
			NL 8801403 A ,B,	02-01-1989
			SE 501938 C2	26-06-1995
			SE 8802046 A	03-12-1988

US 5683278	A	04-11-1997	DE 4434261 A1	28-03-1996
			CN 1129182 A ,C	21-08-1996
			JP 2832427 B2	09-12-1998
			JP 8301186 A	19-11-1996
			NL 1001270 C2	12-11-1996
			NL 1001270 A1	25-03-1996
			RU 2108266 C1	10-04-1998

JP 07310829	A	28-11-1995	JP 2750270 B2	13-05-1998

US 5795198	A	18-08-1998	MC 2367 A	14-09-1995
			AU 689932 B2	09-04-1998
			AU 3087495 A	07-03-1996
			CA 2196680 A1	22-02-1996
			DE 69507304 D1	25-02-1999
			DE 69507304 T2	02-09-1999
			EP 0770017 A1	02-05-1997
			ES 2129211 T3	01-06-1999
			FI 970488 A	10-03-1997
			FR 2723910 A1	01-03-1996
			IT SV950008 A1	12-02-1996
			JP 10504255 T	28-04-1998
			WO 9605100 A1	22-02-1996
			NO 970376 A	19-03-1997
			NZ 290202 A	25-02-1999

JP 11304005	A	05-11-1999	JP 3155505 B2	09-04-2001

EP 0335368	A	04-10-1989	JP 1148171 U	13-10-1989
			JP 5035249 Y2	07-09-1993

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 07 5888

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-07-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0335368 A		EP 0335368 A1	04-10-1989
		US 4984811 A	15-01-1991

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82